SHORT-TERM RETENTION AND RETRIEVAL IN SCHIZOPHRENIA

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A C K N O W L E D G E M E N T S

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A B S T R A C T

Bauman and Murray (1968) found that schizophrenic subjects when compared to normal subjects have a recall deficit, but that their recognition performance on tasks is not impaired. They interpreted their findings as suggesting that schizophrenics have difficulty in the association-forming stage of memorizing, which is reflected by an inability to organize material for retrieval.

This thesis reports a study which essentially repeats Bauman and Murray's research but uses paired-associate learning and a paired-associate analogue of recognition in place of free recall and recognition tasks. Paired-associate recognition involves the selection of the response item for each stimulus word from a larger set of possible response words. This task involves both the selection of a word and the matching of it to a stimulus, whereas the usual recognition task requires selection only.

Results indicated both a recall, and a recognition deficit in paired-associate learning for schizophrenic subjects when compared to normal subjects. It is suggested that the poorer performance by schizophrenics results from their inability to use common associations as aids to retrieval, although the possibility of input overloading in the schizophrenics, cannot be discounted.

I N D E X

S H O R T - T E R M M E M O R Y

BRIEF HISTORICAL BACKGROUND

The field of verbal learning came into prominence in the early nineteen-fifties. Prior to that verbal learning tended to be divided into 'rote learning' i.e. reinforcement or decay of stimulus-response bonds, and 'nonsense syllable research'.

Two major findings of the period which revolutionised this field were: firstly, the distinction between response learning i.e. learning how to make a response in the sense of response integration (Hovland and Kurtz 1952); and associative learning i.e. the connection between a response unit and a particular stimulus (Mandler 1954). This resulted in nonsense syllables falling into relative disfavour as stimulus materials in preference for words (Underwood and Schulz 1959). The second major finding of the period was the possibility that the learning of associative bonds could take place in an all-or-none manner (Estes 1960, Rock 1957). It had previously been thought that the strength of associations among pairs of items grew monotonically as a function of trials rather than as an all-or-none process after a single trial. It was also suggested that increasing experience with a word i.e. practice, makes a particular item more accessible by providing new and additional cues for its retrieval from memory (Miller 1963).

More recently, an orientation viewing verbal learning as a

problem of organization and retrieval from memory, rather than just the establishment of new associations, has become apparent.

WHAT IS SHORT-TERM MEMORY?

As Posner (1967) pointed out, the term short-term memory is used interchangeably to refer to at least three reasonably distinct features of memory systems.

These are, firstly, representational memory which is a very brief memory trace or sensory image (Mackworth 1964, Melton 1963, Sperling 1963), auditary (Broadbent 1958), or kinesthetic (Posner and Konick 1966) in sensory input modality. These seem to be Neisser's (1967) iconic (brief visual memory traces) and echoic (brief auditary memory traces) memories. Representational memory appears to be input via a scanner which determines the sequence of locations known as addresses or pigeon-holes (post-boxes) in memory. Representational memory is therefore a limited sensory store, a series of 'buffer' stores or 'echo' boxes, the contents of which may be determined by a filtering mechanism in attention (Neisser 1967, Norman 1969).

A second feature of memory systems which is often labelled as short-term memory is temporary storage by encoding. This is the way in which external stimulation is put into an internal code and retained at an address. There is some evidence to indicate that both visually and orally presented material are encoded into an auditary store (Conrad 1964, Mackworth 1964). It is assumed to be a limited capacity store in which the retention of items is affected by implicit rehearsal (Sperling 1967), the pertinence of the item (Norman 1968 - a measure of item bias), or due to the number of subsequently queued items (Waugh and Norman 1965 - a 'queue theory').

It is known that short-term store has a limit, probably about seven to ten 'chunks' of information (Miller 1956). These chunks appear to be functional (subject-defined) units, not nominal (experimenter-defined) units (Underwood 1963). The span of immediate short-term memory appears to be limited by the number of items independent of the information content per item (Miller 1956).

A third aspect of the memory systems referred to as short-term memory is operational memory (Jung 1968). This is a retrieval mechanism. It has been shown that while an item of information may be available i.e. stored at a particular location or address, it is not always accessible (Tulving and Pearlstone 1966). The retrieval aspect overlaps with long-term memory i.e. secondary memory containing permanently stored material. Recently activated material in permanent storage is not thought to be returned to short-term memory during a mental operation (Broadbent 1958). There appears to be only one study indicating that recently activated memory is no more susceptible to interference than is dormant long-term memory (Posner 1967). Long-term memory is hypothesized to have unlimited capacity and to be semantic in nature (Baddeley and Dale 1966). It has been defined as memory exceeding retention intervals of more than five minutes (Melton 1963).

Short-term memory as a store or retention device has a more definite status than short-term memory as a retrieval device. Definition of short-term memory is perhaps by elimination i.e. as memory intermediate between a brief sensory buffer and long-term memory. It must also be borne in mind that long-term memory is

itself an arbitrary definition of the length of the experimental retention interval (Melton 1963).

The three types of memory i.e. sensory, primary and secondary, have been proposed as part of a unitary system (Melton 1963). Another advocate of this system views immediate, short and long-term memory as a time continuum between time of input and retrieval. Two different retrieval systems are postulated. The more important of these, is secondary or subjective organization as a system of retrieval (Tulving 1968). A study of cued and noncued retrieval showed that the number of words within accessible categories remained constant regardless of the number of accessible categories (which increased with list length) (Tulving and Pearlstone 1966). Another study showed that while the amount of output remained constant on each trial over three cycles, different items were recalled on subsequent recall trials of the same input list. (Tulving 1967 Experiment II). This study was interpreted as indicating that retrieval i.e. output rather than input, is a limited capacity system. Others have suggested that input functions as a limited capacity system (Norman 1968, Sperling 1967).

RECALL VERSUS RECOGNITION

A number of studies have shown that retention is better in recognition than in recall learning (Luh 1922, Postman and Rau 1957). However others have criticized this finding on the grounds of either proactive interference, the degree of similarity or the size of the population of the recognition alternatives compared to the recall alternatives. Under these conditions several studies have shown the recall method to be superior to that of recognition (Davis, Sutherland and Judd 1961, Field and Lachman 1966, Murdock 1963, Postman, Jenkins and Postman 1948, Slamecka 1966, Tulving 1964, Tulving 1968, Underwood 1957).

Other studies have indicated that retention scores vary directly with the time subjects are allowed for recording their retention (Hollingsworth 1913). It has been found that more information is retained when longer retention recording times are permitted (McNulty 1965). It has also been shown that retention scores vary directly as a function of the total time regardless of the duration of individual trials or intratrial items (Bugelski 1962).

The processes of recall and recognition could be viewed as follows. Recall requires retrieval of information from some storage medium, while recognition appears to be identification by matching of information with the item at a stored address in some storage medium (Norman 1968). While whole item or whole learning seems to occur in recall, only partial learning i.e. retention by storage but not retrieval, possibly occurs in recognition (McNulty 1965).

Therefore recognition could involve retention at a stored address and the decision that the item stored at the address matches a given alternative item. Likewise, recall could involve retrieval of the item from its address in storage following the search and location of the address. Recognition could perhaps be viewed as identification in storage, while recall is viewed as requiring retrieval as well as identification. It can be deduced from this line of reasoning, that organization for retrieval ought to correlate highly with recall performance, but not with recognition performance (Dale 1967). Furthermore, the organization of learning material should have no effect upon recognition performance since organization facilitates retrieval only, and only recall involves retrieval (Cofer, Bruce and Reicher 1966). This contention has been supported by studies showing that retrieval plans or cues are important for recall but not for recognition (Kintsch 1968, Wood 1967).

It has been suggested that when mental deterioration has been incurred, verbal information known by the patient at one time, may be much more easily recognized than recalled; especially in older and more deteriorated individuals. Such a disparity between recall and recognition measures of vocabulary and information has been demonstrated (Glik 1951).

PAIRED-ASSOCIATE LEARNING

Since the experimental lists used in the study reported here consist of paired-associates, a brief review of paired-association is required.

Paired-association appears to be a complex process which can comprise many overlapping processes (ten have been cited by Battig 1968). However because of the difficulty (and impossibility in some cases) of separating these into demonstrable individual experimental variables, convenience and economy suggest a three-factor theory. This involves a) learning of the response term, b) discrimination of the stimulus, c) followed by the formation of an association between the stimulus and response terms (Underwood and Schulz 1959). Association-formation could be hypothesized as an associative linkage facilitating retrieval i.e. the stimulus item provides a retrieval cue for the response item.

Differences in the rate of paired-associate learning can be influenced by small variations in meaningfulness, association value, pronouncibility, and similarity of the stimulus and response items (Jung 1968). The usual procedure is to hold all but one variable being investigated constant, and to use several sets of lists. Common words should be used where it is desirable for the subjects to treat the stimulus and response items as integrated units. An important feature of the stimulus terms is the number of associations they elicit.

If the stimulus and response terms are easily associated then facilitation of learning of the pair is likely to result. Runquist (1966) gives five different relationships which may exist between

paired-associates. These are 1) direct similarity of meaning e.g. unclean - dirty 2) similarity of sound e.g. stuff - rough 3) similarity of identifical elements e.g. XUC - XUH 4) commonality of associations e.g. snow - white 5) a common mediating association e.g. army - ocean, mediated by navy. In constructing a paired-associate list where one type of association is desired i.e. commonality of associations, the other types need to be minimized. For example, as few as possible items should begin, end, or contain, a given letter in a given position, or contain a common syllable, sound, prefix, or suffix.

Paired-associate lists usually average about ten pairs of common words, although a range from four to twenty pairs have been used in experimental studies. Lists of too many items may lead to loss of motivation in subjects.

A number of studies suggest that in order to investigate associative learning between high and low meaningfulness, it is advisable to vary the meaningfulness of the stimulus rather than the meaningfulness of the response term (Dukes and Baston 1966, Epstein, Rock and Zuckerman 1960, Gorman 1961, Horowitz 1966, Paivio and Oliver 1964, Paivio, Smythe and Yuille 1968, Paivio, Yuille and Madigan 1968, Paivio, Yuille and Smythe 1966, Paivio, Yuille and Rogers 1969, Sheffield 1946).

Also it has been shown that it is advisable to use concrete nouns instead of abstract nouns; nouns instead of adjectives and verbs; and finally, content words (nouns, verbs, adjectives) rather than function words (pronouns, conjunctions etc.) (Bower 1967).

In conclusion, the above listed studies point out the relevance

of imagery and concreteness, as well as meaningfulness in paired-associate learning.

S C H I Z O P H R E N I A

WORD ASSOCIATION AND SHORT-TERM MEMORY

The clinical patients employed as subjects in the study to be reported here, were diagnosed as schizophrenics by hospital staff. Previous studies of association and short-term memory in schizophrenia are therefore of direct relevance.

Despite the relatively common use of the diagnosis 'schizophrenia' in cases of mental disorder, many questions concerning the illness remain unanswered. A large amount of research has led to many hypotheses about its nature and etiology. These still remain matters for dispute. (Rosen and Gregory 1965).

Several classification schemes have been proposed for schizophrenia. Johannsen's (1963) factor-analytic study differentiated the acute-chronic, process-reactive, and good-poor premorbid categories, with the paranoid-nonparanoid category as an independent factor cutting across these other categories.

One of the basic psychological deficits said to distinguish schizophrenics from normals is that of thought disorder, particularly the disruption of associative processes. Many schizophrenic symptons (hallucinations, delusions etc.) have been considered elaborations of, and secondary to the primary disturbance in association. This disturbance in association may be exhibited in bizarre ideas, loose associations, fragmented thinking, and in the blocking of usual and common chains of associations and ideas. It was thought that the greater the tendency for stimuli to have individual idiosyncratic

meanings (associations) for a subject, the more the subject would be handicapped relative to normal subjects in tasks involving associations (Bleuler 1930).

Disorganization of associative domains resulting in an inability to restrict these domains, and to judge which responses fall in and outside of them, appears to be a predominant feature of schizophrenic thought disorder. Chronicity (Wynne 1964), length of hospitalization (Higgins, Mednick and Philip 1965), and poor premorbid adjustment (Dokecki and Polidoro 1965), have been shown to impair performance on word-association tests involving primary associations.

Results from associative interference studies indicate that intratask and extratask interference from previously acquired associations is no greater for acute schizophrenics than for normal subjects (Spence and Lair 1964) but was for chronic schizophrenics (Spence and Lair 1965). The finding that schizophrenics form the same kind of concepts, and that their mediation processes are similar to normal subjects (Lang and Luoto 1962), suggests that schizophrenic verbal responses do not break down to the large extent generally believed (Johnson, Weiss and Zelhart 1964). Studies employing distraction items have indicated that schizophrenics make more associative errors as opposed to unrelated errors (Burstein 1961, Downing, Ebert and Shubrooks 1963).

An attention deficit has been hypothesized to partly account for a short-term information processing impairment in schizophrenia. It has been suggested that the rate at which information is processed

by schizophrenics is abnormally slow, and since short-term memory can only hold information for a short time, less information per unit time can be held in buffer storage by schizophrenics. Therefore, only part of the stimulus material will be successfully processed (Yates 1966). Thus short-term memory impairment in schizophrenics may be a function of the rate of presentation of information at the input phase.

Another recent study (Smith 1969), in which chronic schizophrenics were compared with chronic non-schizophrenics, showed the schizophrenics to be markedly inferior both in initial acquisition of information (input into buffer storage), and maintenance of it in storage (short-term store). The results of this study raise four controversial question i.e.: 1) do short-term items decay faster with schizophrenia, 2) do schizophrenics tend to rehearse less than controls, 3) do schizophrenics misuse the opportunity for rehearsal by making implicit distracting associative responses to each stimulus (this is the associative disorganization suggested by Phebe Cramer's 1969 study), or 4) do schizophrenics use less efficient guessing strategies?

These queries are some of the unanswered questions at present existing in the field of schziophrenic thought disorder and short-term memory. The specific focus of this thesis is on the associative aspect of short-term memory in storage and retrieval. With more highly organized material (high-association commonality as compared to low-association commonality), will schizophrenics perform as well as normal subjects, or, will output inference make retrieval more difficult for them, as suggested by Bauman (1969)?

PHENOTHIAZINE DRUGS AND SHORT-TERM MEMORY

Because most schizophrenics receive medication and because the most general class of drugs prescribed for schizophrenics are Phenothiazine derivatives; the effects on behaviour of these drugs will now be discussed.

Two paired-associate studies have indicated that Phenothiazine derivatives may enhance retention (Dastin 1959), or give rise to impairment only when both learning and retention occur under Phenothiazine medication (Vestre 1961). A concept generation task measuring the intrusion of associatively-linked distractors showed that a Phenothiazine derivative did not produce a decrement significantly different from the placebo condition, while other drugs did (Downing, Ebert and Shubrooks 1963).

In summary, these studies tend to suggest that Phenothiazine drugs do not markedly affect memory or learning ability. There is even a possibility that they may enhance performance. It has been suggested that if only those schizophrenics who were not on medication were used in experimental studies, then a biased sample would be obtained because only those patients who could safely be taken off medication, would be used as subjects in research (Bauman and Murray 1968).

EXPERIMENT

OUTLINE OF BAUMAN AND MURRAY'S STUDY

Bauman and Murray's (1968) study is described in detail because the research to be reported essentially follows their design.

They suggested that because of overinclusiveness (Cameron 1939, Payne, Matussek and George 1959), or overgeneralization (Mednick 1958), schizophrenics would differ from normals in that they would find the recall of verbal items more difficult than their recognition. The rationale offered was that in recall a subject has to scan a very wide repertoire of internal responses in order to respond, whereas in recognition he has only to select a response from a limited external list. They reported that schizophrenic performance relative to that of normal subjects was equivalent on recognition tasks but poorer on recall tasks. (Blatt 1959, Nachmani and Cohen 1967).

Bauman and Murray employed two equivalent lists of twenty four-letter stimulus words (equated for word frequency). In the recognition task each stimulus word was provided with a rhyme, a synonym, and a synonym-rhyme to make four alternatives per list word. Stimulus words were presented for three seconds on a memory drum and subjects read the words aloud. In recall, subjects wrote down as many words as they could remember, while in recognition they were given a sheet containing eighty words (twenty stimulus words, twenty rhymes, twenty synonyms and twenty synonym-rhymes)

in a random order and were instructed to circle the twenty words that had previously been shown on the memory drum. The design was counterbalanced so that half the subjects in each group did the recall task first, and the other half did the recognition task first. In addition to this each subject was given the Mill-Hill Vocabulary Scale, the Goldstein-Scheerer and the Object Classification test of overinclusiveness.

The study employed 15 female and 9 male schizophrenic patients with a median hospitalization period of approximately six months (also including 4 much longer-term patients), and 24 normals (14 males and 10 females) of similar age and verbal intelligence. All patients were on Phenothiazine medication and eleven were diagnosed as paranoid.

Bauman and Murray found that recognition scores were superior to recall scores for both normals and patients. No significant differences were found on measures of recognition or overinclusiveness between normals and patients. The recall/recognition ratio was significantly lower for patients. There being no difference between normals and patients on tests of overinclusiveness, both groups were further subdivided into overinclusive and non-overinclusive subgroups. Only the non-overinclusive patients failed to show a tendency towards making a greater proportion of synonym and rhyme-errors.

The study appeared to rule out overinclusiveness as a significant variable in schizophrenic performance. The most significant finding was that of a recall deficit in schizophrenics as compared to normals. The study suggested difficulty in the association-forming stage of recall, due to an inability to organize

material for appropriate retrieval. It was postulated that this organizational inadequacy caused greater retrieval interference in the schizophrenic than in normal subjects.

AIMS OF PRESENT STUDY

A replication of Bauman and Murray's study using a paired-associate recall and paired-associate recognition tasks in place of free recall and recognition could produce further evidence in favour of a retrieval deficit in schizophrenia. Further, by having subjects perform paired-associate tasks rather than free recall and recognition (of word lists), and by varying the degrees of commonality of association between the items in the word pairs, the nature of the retrieval deficit can be more closely examined.

If schizophrenic recognition scores are no different from those of normals, as Bauman and Murray found, then in a paired-associate recognition task, can schizophrenics match the recognised response word to its correct stimulus as readily as normal subjects? If schizophrenics find this task more difficult than normals, it suggests that the associative links between words in each P-A pair do not facilitate organization for retrieval to the same extent in schizophrenics as in normal subjects.

It is hypothesized, then, that schizophrenic performance on P-A recognition tasks, will be inferior to the performance of normal subjects. Further, P-A learning is more difficult when word pairs of low commonality of association are used. (Runquist 1966). This could be interpreted to suggest that low associative bonds between stimulus and response do not facilitate recall of response words in P-A learning, to the same degree as do words with high associative bonds. If schizophrenics make less use of the degree of commonality of association between words in P-A pairs

on P-A learning tasks, any difference between the P-A recognition scores of normals and schizophrenic subjects should be less when low commonality of association exists between the words in P-A pairs. This is because the advantage for normals in utilizing associative bonds in correctly matching response word to stimulus word, is reduced with pairs of low association. It is hypothesized then, that the difference between the number of correct stimulus-response matchings of normal and schizophrenic subjects on a P-A recognition task decreases with a decreasing commonality of association between the words in P-A pairs.

On the basis of the recall deficit associated with schizophrenia found by Bauman and Murray, it is hypothesized that schizophrenic subjects will have greater difficulty than normals on P-A recall tasks. Further, it is hypothesized that the difference in performance between normal and schizophrenic subjects on a P-A recall task will lessen with lists of lower commonality of association between words in P-A pairs.

EXPERIMENTAL DESIGN

An attempt was made to control for order effects of recall and recognition, of low and high association, and to minimize proactive interference by counter-balancing on two consecutive days. Four lists of ten paired-associates were presented to each subject. Equal numbers of male and female subjects were used in each counterbalanced unit of the design. Approximately, one third of the schizophrenic sample were diagnosed paranoid. The matching of male and female schizophrenics for length of hospitalization and acute versus non-acute (with two years from first hospitalization as the cut-off for chronicity), was attempted. An age-range between 18-40 years (Bauman and Murray's study 24-39 years) with a mean age of 25 (Bauman and Murray - 31 years) years was envisaged. Details of educational achievement, occupation and the Mill-Hill Vocabulary scores were used to equate the normal and schizophrenic samples for intelligence. There was a tendency for schizophrenic subjects to spend a longer time at secondary school and to obtain lower IQ grades on the Mill-Hill. As brighter students tend to stay at secondary school longer than three years, the value of the Mill-Hill Scale as an accurate indicator of premorbid IQ is perhaps questionable.

(Appendix H)

The design employed the following four conditions:

		DAY 1		DAY 2	
Condition		High Recall → High Recognition		Low Recall → Low Recognition	
1	3Ss	b - a	h - g	f - d	l - j
	3Ss	e - d	k - j	c - a	i - g
		Low Recall → Low Recognition		High Recall → High Recognition	
2	3Ss	f - d	l - j	b - a	h - g
	3Ss	c - a	i - g	e - d	k - j
		High Recognition → High Recall		Low Recognition → Low Recall	
3	3Ss	h - g	b - a	l - j	f - d
	3Ss	k - j	e - d	i - g	c - a
		Low Recognition → Low Recall		High Recognition → High Recall	
4	3Ss	l - j	f - d	h - g	b - a
	3Ss	i - g	c - a	k - j	e - d

* Letters a to k refer to stimulus or response word lists.
* Ss refers to subjects.
* High and low refer to degree of commonality of association of words in each P-A pair.

List set I contained lists: High Recall b-a, Low Recall f-d, High Recognition h-g, Low Recognition l-j
List set II contained lists: High Recall e-d, Low Recall c-a, High Recognition k-j, Low Recognition i-g.

There were six subjects within each of these conditions. Three of the subjects in each condition received set I lists of words, while the remaining three subjects received set II lists, i.e. of the total 24 normal subjects (6 subjects per four experimental conditions), 12 subjects received set I lists and 12 received set II lists. Each subject received four lists, two on each day.

The same total procedure as outlined above was employed for the schizophrenic group of 24 subjects.

METHODS USED

Recall in paired-associate learning consisted of presenting all the pairs of words (each pair comprising a stimulus and a response word) successively, for a fixed length of time per pair. This was followed by an unpaced written test of retention of response words when only the stimulus terms in each pair were presented. Retrieval of the response item plus correct matching of it to the appropriate stimulus was required for each stimulus item.

Pairs of word for the recognition task were presented in the same manner. However the retention test required the subject to select the appropriate response for each stimulus word. Thus selection of the response item plus their correct matching to the appropriate stimulus word was required.

EXPERIMENTAL PROCEDURE

Two sessions, one of one hour, one of quarter of an hour, on two consecutive days; in the afternoons for clinical subjects, and in the evenings for normal subjects; were carried out.

The first session consisted of a brief interview for details of age, education and employment. The synonym (self-administered) and definitions (experimenter-administered) tests of the 1947 Mill-Hill Vocabulary Scale (without any time limit) was then given. In session I, the interview was followed by either the recall or recognition task. Subjects were given either recall or recognition instructions (Appendix D), an answer-sheet (face-down) and a pencil. They were told they would see the words 'Start' and 'Finish'. They were to fill in the answer-sheet immediately they saw 'Finish'. Lists were presented at the rate of one second per pair of words. The rate of presentation was intended to enable subjects to read each pair but to minimize opportunities for rehearsal or time to form idiosyncratic mediations. The Lafayette Memory Drum was switched off as the word 'Finish' appeared. Unlimited time was given to complete the answer sheets but most subjects completed the task within two minutes. The second set of instructions (recognition, if recall was given on the first test or vice versa) and the same procedure, was employed on the second task.

The second session on the day following session I, where subjects were again tested individually, required completion of a further set of recall and recognition lists. These were followed by two brief questionaires. Each was read to the subject. He was given a copy to follow, also. The subjects' responses were recorded on these questionaires.

LIST CONSTRUCTION

Words used in P-A lists were four-letter nouns which were as far as possible concrete nouns although many of the stimulus nouns can and do, function as adjectives e.g. iron - ring, or as verbs e.g. play - mate. There was only one non-noun adjective e.g. grim in grim - luck.

There were ten pairs of words in each of eight lists. The lists were constructed with the aid of Rogets' Thesauras, the Thorndike-Lorge Word Frequency General Count, the Oxford Dictionary (1931) and Bauman and Murray's (1968) list.

The type of association used between stimulus and response words was commonality of association e.g. sail - boat. A synonym to each response was found e.g. ship for boat in sail-boat, and rhymes to both the response and the synonym e.g. vote (boat) and slip (ship). The mean frequency count (Thorndike-Lorge) of the stimuli responses, synonyms, rhymes and synonym-rhymes in each list were as near equated as possible, and mean word frequencies between lists were also similar. (Appendix A). The high commonality of association lists were constructed first, and the low commonality of association lists were constructed simply by altering the stimulus items. Since it has been suggested that response items are more influential in association formation than stimulus items (Dukes and Baston 1966, Epstein et al 1960, Paivio et al 1968), stimuli rather than responses, were altered, in an attempt to keep the high commonality of association of Set I lists as similar as possible to the low commonality of association set II lists and vice versa. In fact, set I high commonality of association, and set II low commonality

of association lists and vice versa are identical apart from the stimulus items of the pairs. This is true of both recall and recognition.

An attempt was also made to keep intra-item interference to a minimum; employing where possible, stimulus and response items in the one list with not more than two words beginning or ending with the same syllable, sound, or consonant, and with not more than two words sharing the same sound e.g. blow, glow. Also the elimination of consecutive stimulus or response items, beginning or ending with the same consonant or sound, in the presentation of the lists (on the memory drum), and in the answer-sheets, was attempted.

Lists in sets I and II were equated on the basis of pilot studies using eight groups (76 students from Christchurch Teacher's Training College) with a mean age of 18 years 6 months (range 17-25 years). White cardboard sheets (10" x 8") with words typewritten in upper caseletters (a $\frac{1}{4}$" in height) with double spacing between individual letters, with $2\frac{1}{2}$" between the stimulus and response words of each paired-associate and 1" between each pair of words laterally, were used. Each pair of words was individually exposed by sliding a large sheet of cardboard with a horizontal strip cut in the middle of it, over the sheet on which the words were typed. Subjects were tested in groups of ten (except the last group of six). They stood within five feet of the words and were shown each pair of words for two and a half seconds (using a stopwatch). Prior to list presentation, subjects were handed either recall or recognition instructions (Appendix B). Verbal instructions of 'Start', 'Finish', and 'The order of presentation on these lists of the word pairs will

not be the same as on your answer sheet', were also given. After list presentation, subjects immediately recorded their answers on the answer sheet (Appendix C). The same procedure was followed for a second list.

Items in lists were interchanged and tested on a new and additional group of subjects, until a set of lists with similar means and variances (Appendix B) were found. These are presented in Appendix C.

CLINICAL SUBJECTS

Of the twenty-four schizophrenic subjects approximately one third were voluntary patients while the remainder had been legally committed. Approximately one third were diagnosed as 'paranoid' and one third simply diagnosed as 'schizophrenia'. Other subcategories of schizophrenia were also used. The mean and median hospitalization period in months for female patients was 2.75, 1.33 respectively and for the male patients was 2.25, 1.0 respectively. Three-quarters of the patients had been hospitalized for less than three months and the other quarter less than nine months. The majority appeared to be suffering from acute rather than from chronic disturbances. One third of the patients (three females, five males) had had one or more previous admissions. If the distinction between acuteness and chronicity is made at the two year cut-off point (by earliest psychiatric hospital admission), then four patients (two females, two males) could be adjudged chronic. (Appendix F).

MATCHING OF NORMAL AND CLINICAL SUBJECTS

The matching of normal and patient samples was mainly in terms of occupation. Differences between samples on IQ grades and also by age, on the Wilcoxin Rank Sum Test gave non-significant results ($p > .05$, $p > .2$ respectively). Differences were also non-significant (χ^2 $p > .5$) for level of attainment of secondary schooling.

Half of each sample was female, and the other half male. There were twenty-three Europeans and one male Maori in each sample Two-thirds of the normal sample were married. Less than one third (six only) of the clinical sample were married, and of these, only one was male. (Appendix G).

QUESTIONNAIRES

The first questionnaire (Appendix E) sought to show which of the tasks, recall or recognition, subjects found the easier. Generally, recognition is assumed to be the easier task but results from the pilot study on the high-association condition indicated that the reverse held for these particular lists. Also the recognition task as employed here, is not merely an identification task but involves a second step, that of correctly matching the response with the stimulus items.

Secondly, the questionnaire aimed at evaluating the rate of practice i.e. whether practice from the first to the second session either outweighed or negated the high to low, or conversely the low to high-association commonality inherent in the construction of the lists. It was possible that the practice effect could have influenced schizophrenic subjects more than normal subjects or vice versa.

The third aim of the questionnaire, was to investigate perception or attention in schizophrenics as compared to normals. It has been suggested that schizophrenics process incoming information at a much slower rate than normals i.e. that they have an input deficit (Yates 1966). Attention and concentration are also thought to be impaired in schizophrenia (Henderson and Batchelor 1962). However, sufficient medication may cancel this factor.

The second questionnaire (Appendix E) was designed to investigate the type of mediation used by subjects in retaining

the paired-associates. A number of previous studies suggested the type of mediations commonly employed by subjects e.g. auditary (Wickelgren 1969), verbal, imaginal(Bugelski, Kidd and Segmen 1968, Paivio, Yuille and Smythe 1966), and repetition (Yuille and Paivio 1968).

In their 1969 study, Paivio and Yuille employed a mediation questionnaire in which they probed five possible techniques of mediation. These were -

1) verbal mediators (a word or phrase connecting the members of a pair) - Question 9 in the present questionnaire.

2) Imagery - a mental image or picture - Questions 5 and 6 which probe imagery in the low association pairs as distinct from stimulus-response imagery in the high-association pairs.

3) 'Other' mediators (letter or sound similarity) - Questions 1, 2 and 3.

4) Rote repetition - Questions 7 and 8.

5) No particular strategy. This covers the gamut of idiosyncratic strategies - Question 10. In addition to these five, visual as opposed to verbal mediation was incorporated into the questionnaire - Question 4.

A five-point rating scale, as used by Paivio and Yuille to investigate frequency of usage was not used; as the type, rather than the quantity of mediation is all that could be revealed with the number of items employed in the lists used.

RESULTS

Recall - Recognition Scores

Since it was hypothesized that normals and schizophrenics would differ both in their ability to perform paired-associate recall tasks, and in their ability to perform paired-associate recognition tasks, it was predicted that the difference between recall and recognition would not be greater for schizophrenics than for normals. A two-factor analysis of variance, appropriate, for the high-association recall and the high-association recognition results upheld this latter hypothesis, the interaction between groups and tasks being non-significant.

TABLE 1. ANALYSIS OF VARIANCE - HIGH ASSOCIATION DATA

SOURCE	SS	df	MS	F
Between	472.4062	47	168.0103	25.3896
A - Groups	168.0103	1	6.6173	
Ss within groups	304.3959	46		
Within Ss	140.5600	48		
B - Recall - Recognition	14.2604	1	14.2604	5.2114
AB interaction	.8439	1	0.8439	<1
B x Ss within groups	125.3957	46	2.7260	
Total	612.9062			

The ratio of MS Ss within a_2 (schizophrenics to MS Ss within a_1 (normals) of 2.69 is greater than $F_{max.95}$ (2,23). These sources of variation are hetrogeneous and no test of difference between recall and recognition is thus made.

The ratio of MS B x Ss within a_2 to MS B x Ss within a_1 of 1.0399 is less than $F_{max.95}$ (2,23). The obtained F of 5.2114 is greater than $F_{.95}$ (1,46) but less than $F_{.99}$ (1,46), $p < .05 > .01$. For both tasks combined, the mean number of correct matches for normals of 7.35 is significantly greater than that for schizophrenics where the corresponding mean is 4.71.

For a comparison of the groups on each task the MS within cells (pooled variation of all 4 cells) is the appropriate error term, although Kirk (1968 P.265) recommends that where hetrogeneous sources of variance are involved, an error term based only on the within cell variance of the cells actually compared, be used. For recognition, this procedure yields $t = 4.299$ (46df) $p < .0005$, one-tail, in favour of the mean number of correctly matched recognitions of 6.87 for normals being significantly greater than the corresponding schizophrenic mean of 4.42. For recall data, the ratio of variances of schizophrenic and normal scores of 2.60 is greater than $F_{max.95}(2,24)$. The Welch approximation to the t' distribution (Winer 1962, p.36-39) for use with hetrogeneous data was employed, $t = 4.216$ using 24df (a conservative test) $p < .0005$, one-tail, clearly indicating superior performance by normals (mean recall 7.83) on the recall task. The mean recall for schizophrenics was 5.00.

Due to skewing, the small range of results, and the number of zero scores, an analysis of variance was not appropriate for low association recall and low association recognition data. Separate 2 x 2 contingency tables of the scores of normals and schizophrenics were constructed and one-tail Fisher Exact Probability tests applied. On both tasks, significantly more schizophrenics obtained zero scores.

TABLE 2. LOW ASSOCIATION RECALL AND RECOGNITION

RECALL				
		Normals	Schizophrenics	Fisher Exact 1-tail Probability
Number of correct matchings	1 - 4 0	20 4	15 11	.0299
		RECOGNITION		
Number of correct matchings	1 - 5 0	22 2	15 9	.0182

Questionnaire Data

Questionnaire I

1a) Non-significant results were obtained on a Fisher Exact Probability test on the numbers of subjects stating either the recall or the recognition task as the more difficult.

TABLE 3. TOTAL NUMBER OF SUBJECTS FINDING EACH TASK AS THE MORE DIFFICULT

	NORMALS	SCHIZOPHRENICS		
Recognition	13	13	26	$p > .10$
Recall	10	11	21	
	23*	24		

* One normal found each task equally difficult.

1b) A slight practice effect, due to finding the low association tasks given on the second day (of the two consecutive days) easier, than the high association tasks given on the previous day, was claimed by four of the schizophrenics. No practice effect was claimed by any of the normal subjects.

2) A Fisher Exact Probability Test indicated that the amount of time given to read the P-A pairs, as reported by the subjects, was adequate.

TABLE 4. TIME ELEMENT

	NORMALS	SCHIZOPHRENICS	
Right amount of time	16	13	$p > .05$
Too little time	8	11	
	24	24	

Questionnaire II

Introspection on the method of retention of the experimental material by the subjects indicated that imagery (42%) and repetition (46%) accounted for 88% of the normals' responses and 80% of the schizophrenics' responses (imagery 33%, repetition 47%).

Errors

A mismatch is an identified but incorrectly matched (with P-A stimulus word) P-A response word. Opportunity for mismatching, is the number of mismatches made by a subject in one of the four tasks, divided by ten minus the number of correct items to give the number of mismatches possible. Thus, opportunity for mismatching, is the proportion of mismatched to possible total of mismatched, items. Scores, both for mismatching and for mismatches as the opportunity for mismatching, for normal and schizophrenic subjects were found to be non-significant, on low and on high association recognition tasks using Kolmogorov-Smirnoff two-sample tests. For high and low association recall, mismatching for both groups of subjects was also nonsignificant.

TABLE 5. HIGH ASSOCIATION RECALL MISMATCH RESULTS

	NORMALS	SCHIZOPHRENICS
No. making mismatches	0	3
No. making no mismatches	24	21
Total No. of mismatches	0	6

TABLE 6. LOW ASSOCIATION RECALL MISMATCH RESULTS

	NORMALS	SCHIZOPHRENICS
No. making mismatches	10	10
No. making no mismatches	14	14
Total No. of mismatches	14	12

No significant difference between groups on any task was found for omissions i.e. blank spaces besides P-A stimulus words -.

Any response which is not a correct response or a mismatch (identified response) is an intrusion. Intrusions in the high association recognition task were treated by the Welch approximation to the t' distribution (Winer P.36-39) because the variances for the two groups were hetrogeneous. This gave $t = 3.29$, $p < .01$ in favour of normals making fewer intrusions (Normals mean = 2.46, schizophrenics mean = 4.29). Normals again made fewer intrusions with the low association recognition items ($t = 3.57$, 46df, $p < .01$, normals mean = 3.55, schizophrenics mean = 5.62). No significant differences between the groups were found on the high and low association recall task where Kolmogorov-Smirnoff and Fisher-Exact tests respectively were applied (because the large number of zero intrusions precluded other modes of analysis).

Serial Position Effects

In order to determine serial position effects on high association recall and recognition tasks, the average proportion correct for each task separately in the first three, middle four, and last three presentation positions, was obtained for each subject. This was achieved in the case of the first three stimulus-response pairs presented, by dividing the number of correct matchings in the first three positions by three times the number correct for that subject on that task. In the case of the middle four presentations, a divisor of four times the total number correct was employed. The recall and recognition data so obtained were separately treated in a groups-by-presentation position analysis of variance. Any differences between groups was removed by the process of treating scores as proportions of totals, and therefore group differences were nonsignificant. For both recall and recognition there was a tendency for a greater proportion of correct matchings to occur in the first three positions. For both sets of data conservative tests (df = 2,46 instead of 2,92) were made (Kirk 1968 p.262) because F_{max} tests indicated hetrogeneous sources of variance. Recall data, $F = 3.217$, $p < .05 > .01$ by the usual test failed to reach significance with conservative degrees of freedom, while the recognition data, $F = 5.255$, $p < .05 > .01$ using conservative degrees of freedom permitted rejection of a hypothesis of no serial position effect. For neither set of data did the groups by position interaction approach significance. There was no difference between the groups in the way in which position affects recall or recognition.

TABLE 7. MEAN NUMBER OF ITEMS CORRECTLY MATCHED AS A FUNCTION OF SERIAL POSITION

HIGH RECALL

	First 3 items	Middle 4 items	Last 3 items
Schizophrenics	.112	.075	.085
Normals	.103	.090	.101

HIGH RECOGNITION

Schizophrenics	.117	.075	.080
Normals	.120	.101	.068

Because of the small total number correct for low association recall and recognition tasks any analysis of serial position would be based on very few observations. Table 8 gives the total number of correct matches for all subjects in each group in the first three, middle four and last three serial positions.

TABLE 8. TOTAL NUMBER OF ITEMS CORRECT - LOW ASSOCIATION

LOW RECALL

	First 3 items	Middle 4 items	Last 3 items	Total no. of items correct
Schizophrenics	5	10	10	25
Normals	3	9	20	32

LOW RECOGNITION

Schizophrenics	8	6	11	25
Normals	4	9	26	39

These data suggest a recency effect for both groups (although P-A stimulus items on the recall and recognitions tests were in a scrambled order thus differing from their order on the memory drum in presentation).

A further analysis of recency effects, involved comparing the number of subjects in each group who correctly matched the last stimulus presented. This was done separately for both high and low association recall and recognition. In all cases, more normal than schizophrenic subjects correctly completed the last item although only the high recall and high recognition data gave significant results (Fisher Exact Probability two tail, $p = .0198$ and $p = .0392$ respectively). Low association data approached significance. However, in the case of the high association data, the difference in favour of stronger recency on the part of normals disappears when account is taken of the greater total number of correct matchings made by normals. If no serial position effects exist, one tenth of the total number of correct matchings should occur in the last serial position, and this expected frequency can be compared with the actual number of correct matchings in the last serial position. Table 9 gives the relevant data for both groups of subjects on high association tasks.

TABLE 9. OBTAINED AND EXPECTED NUMBER OF CORRECT MATCHINGS IN THE LAST SERIAL POSITION

		NORMALS		SCHIZOPHRENICS	
		Correct	Incorrect	Correct	Incorrect
RECALL	Expected	18.8	5.2	12	12
	Obtained	17	7	8	16
RECOGNITION	Expected	16.5	7.5	10.6	13.4
	Obtained	18	6	10	14

Chi Squares were calculated on each of the four sets of data in the table. No tendency for any group towards a recency effect was evident.

Summary

Results support the hypotheses that normal subjects are more able than their schizophrenic counterparts to perform paired-associate recall and recognition tasks using word pairs of both high and low commonality of association.

An analysis of serial position effects (when proportion of items in relation to the total number of items correct was taken into account) revealed a primacy effect for the high association recognition task, and a suggested primacy effect for high recall for normals and schizophrenics. A nonsignificant interaction between groups and position indicates that this primacy effect operates to a similar degree for both groups.

Schizophrenic subjects made significantly more intrusions than normals on recognition but not on recall tasks. Groups did not differ significantly in number of omissions or mismatches.

Approximately two-thirds of both groups felt that the exposure time allowed sufficient time for the words to be read.

DISCUSSION

Difficulty in recall for schizophrenics as postulated by Bauman and Murray, has been shown here for high and low commonality of association through the use of paired-associates. This tends to corroborate the studies cited earlier which showed impairment of primary (the first responses commonly elicited) responses on word-association tests.

Difficulty for both high and low commonality of association in paired-association was found on the recognition tasks for schizophrenics. The recognition paralog as used here, differs from the conventional recognition task which involves recognition only. It has been shown that schizophrenics do not differ from normals on the task of recognition identification (Bauman and Murray, 1968). It is suggested that the matching stage of the recognition paralog task as employed in this thesis is more difficult for schizophrenics than for normals, since the matching of the response to the stimulus in the paired-associate task involves both identification and correct matching i.e. the forming of an association between the stimulus and the response item.

Bauman (1969a) investigated the possibility that schizophrenics are unable to utilize stimulus cues for the formation of associative bonds at input. He found that there was no significant difference between schizophrenics and normals in their ability to profit from increased organization at input. In a later experiment (Bauman 1969b) results suggested that (for free and for forced order recall but not for recognition), the recall deficit of schizophrenics is due partly

to a) their inability to subjectively organize memory traces i.e. to chunk their data, and b) their abnormally slow rate of processing input i.e. overloading of their short-term store especially at fast input rates (Yates 1966) and c) failure to show a recency effect due to interference at output. Bauman postulated that schizophrenics were unable to organize stored material for recall even with the aid of specific instructions for organization because interference rendered certain stored traces irretrievable.

It is possible that the rate of presentation of the paired-associates (one per second) in the study reported here did cause overloading of the short-term store in schizophrenics although similar proportions of both groups claimed the time to be adequate. (Bauman's 1969 rate of presentation was one trigram every three seconds). If overloading did occur, then a significant primacy effect would be expected for schizophrenics but not for normals. The data did indicate some tendency to primacy in schizophrenics compared with normals but it was nonsignificant. Likewise the data indicates that schizophrenics, on the whole show less tendency towards recency than do normals. Again, the difference was not significant. Nevertheless, these tendencies together with significantly more intrusions on the recognition tasks but no differences in omissions or mismatches for schizophrenics, tend to indicate some overloading causing interference at the input phase. The factor of possible overloading, raises the query as to whether schizophrenics are fully utilizing stimulus cues for the formation of associative bonds, at input. If they do not, then some confounding of association-formation is occurring in the paired-association. Schizophrenics could thus be

handicapped in two ways, namely, by disruption of their associative processes (schizophrenic thought disorder) and by their abnormally slow rate of processing information (Yates 1966).

In the light of the foregoing, E. Smith's (1969) study raising the questions of faster decay, less rehearsal, inefficient guessing strategies, and implicit distracting associative responses for schizophrenics, are worth consideration. Faster decay has been shown not to hold for schizophrenics by Bauman and Murray's recognition identification task. Schizophrenics do not claim to rehearse less or to use different methods to aid remembering than do normals (Questionnaire II). Schizophrenics in providing more intrusions but not omissions or mismatches on recognition, may appear to support the contention that schizophrenics use less efficient guessing strategies. Associative disorganization is possibly detracting from the schizophrenic's ability to form associations and thus to their inability to chunk data (Bauman 1969b).

CONCLUSIONS

Results preclude a clear cut definitive statement that difficulty in the association-forming stage alone, is contributing to the recall and recognition deficit. Rather, two factors appear to be operating. Overloading appears to be causing some interference at the input phase and confounding the associative-deficit factor. Bauman's (1969 a and b) studies suggest that the association-forming deficit is due to retrieval (output) and not to retention (as input did not differ significantly for normals and schizophrenics). Since the usual recognition method involving only identification was not employed in the present study, the methods of recognition versus recall cannot be used to demonstrate retention versus recall i.e. storage versus retrieval. While there is some evidence of associative disorganization in schizophrenic thinking when common and especially primary associations are involved, recognition tests of separate stimulus and response-items are necessary to clearly establish this. Investigation along these lines is at present being undertaken.

FUTURE SUGGESTIONS

In relation to this thesis, a recognition method employing identification only, to be given to all subjects in addition to the recognition method already employed, is suggested. Also the low recall lists may need reconstructing so as to introduce a little more association in the stimulus items when matched with the response items. These findings could be extended by a repetition of the design using a different form of association e.g. direct similarity of meaning or common mediating association, to investigate their generality. Pictorial or auditary material could be used to investigate generality due to different methods of presenting experimental material and to different modalities.

A completely new approach in separating retention and retrieval is also suggested. This is an experiment incorporating Tulving and Pearlstone's 1966 study and Tulving's 1967 study into a single clinical study. The 1966 study involved auditary presentation of three list lengths (12, 24 and 48 words) with either 1, 2, or 4 words per category in each list. There was a cued and a noncued condition. In the 1967 study (Group R - the third group) six cycles of four periods each, were given to each subject. These four periods for Group R involved one input period (presentation of material) and three output periods (retention tests). All subjects learned two lists presented visually on a memory drum. A study using two list lengths (30 and 60 words) with either 3 or 6 words per category, with either cued or noncued retrieval and employing normal and schizophrenic subjects might be useful. It is aimed at separating

retention from retrieval by the use of cued and noncued retrieval conditions, at investigating subjective organization for list lengths and number of words per category within each list, and also for showing the 'trading relation' between various retrieved items on consecutive output periods, and cycles. A main intention is to show that the amount retrieved on any one output period is limited. The basic aim is to demonstrate that the amount of subjective organization and retrieval per modality is less (due to interference) for schizophrenics than for normals.

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APPENDIX A

THORNDIKE-LORGE GENERAL FREQUENCY WORD COUNT

TABLE 1

Frequency of occurrence per 1,000,000 words.
Taken from 'The Teacher's Word Book of 30,000 Words'.

Lists are as presented on the Lafayette memory drum.

High Association Recall Lists

LIST B-A

BOOT	37	LACE	32
DIAL	8	TONE	50
JAIL	22	CELL	50
PALM	37	LEAF	27
SHOP	100	DOOR	100
GOLF	26	CLUB	100
FISH	100	POND	30
TOWN	100	HALL	16
FLEA	4	BITE	33
BASE	100	LINE	100
	534		538
MEDIAN	37	MEDIAN	42
MEAN	53.4	MEAN	53.8

LIST E-D

PORK	14	CHOP	29
BLOW	100	PIPE	50
NAIL	50	FILE	43
FILM	31	STAR	100
GERM	10	FREE	100
BARB	2	WIRE	50
PLAY	100	MATE	48
GLOW	50	WORM	37
TEAR	100	DROP	100
CAMP	100	SITE	21
	557		578
MEDIAN	50	MEDIAN	49
MEAN	55.7	MEAN	57.8

Low Association Recall Lists

LIST C-A

FIRE	100	LACE	32
MILL	50	TONE	50
LIST	50	CELL	50
WINE	50	LEAF	27
SPUR	23	DOOR	100
MARK	50	CLUB	100
GEAR	100	POND	30
TAIL	50	HALL	16
DEBT	50	BITE	33
JOKE	32	LINE	100
	555		538
MEDIAN	50	MEDIAN	42
MEAN	55.5	MEAN	53.8

LIST F-D

DECK	50	CHOP	29
COPY	50	PIPE	50
GIFT	50	FILE	43
FOOD	100	STAR	100
PACK	50	FREE	100
DESK	50	WIRE	50
SOAP	37	MATE	48
CASE	100	WORM	37
BEAN	43	DROP	100
GLUE	15	SITE	21
	545		578
MEDIAN	50	MEDIAN	49
MEAN	54.5	MEAN	57.8

HIGH ASSOCIATION RECOGNITION LISTS

LIST H-G

				RHYME		SYNONYM		SYNONYM-RHYME	
MAIN	50	LAND	100	BAND	50	SOIL	100	BOIL	50
LAMP	50	POST	100	HOST	45	POLE	50	ROLL	100
SOLO	3	SONG	100	GONG	4	TUNE	32	MOON	100
NECK	100	ACHE	28	LAKE	100	PAIN	100	GAIN	100
SAIL	100	BOAT	100	VOTE	100	SHIP	100	SLIP	50
HAND	100	CLAP	22	SNAP	49	BANG	14	GANG	25
GRAY	100	DUST	50	RUST	18	SAND	50	RAND	3
HEAD	100	LASS	9	MASS	50	MAID	50	RAID	11
SOUP	36	DISH	50	WISH	100	BOWL	50	COAL	100
DEAF	19	MUTE	11	ROOT	50	DUMB	34	CHUM	4
	658		570		566		580		543
MEDIAN	75	MEDIAN	50	MEDIAN	50	MEDIAN	50	MEDIAN	50
MEAN	65.8	MEAN	57.0	MEAN	56.6	MEAN	58.0	MEAN	54.3

LIST K-J

				RHYME		SYNONYM		SYNONYM-RHYME	
WOOL	50	SHOW	100	SNOW	100	FAIR	100	PEAR	21
LEAP	50	FROG	25	CLOG	4	TOAD	15	MODE	23
HYMN	18	BOOK	100	LOOK	100	TEXT	17	NEXT	100
GOLD	100	LINK	24	PINK	50	JOIN	100	COIN	50
ROAD	100	CODE	21	LOAD	50	RULE	100	COOL	100
IRON	100	RING	100	KING	100	LOOP	15	COOP	3
SURF	4	WAVE	100	CAVE	33	FOAM	21	COMB	19
HAIR	100	COAT	100	GOAT	50	SKIN	100	GRIN	21
GRIM	22	LUCK	46	DUCK	49	FATE	50	DATE	100
NOSE	100	MASK	17	TASK	50	HOOD	21	WOOD	100
	644		633		586		539		537
MEDIAN	75	MEDIAN	73	MEDIAN	50	MEDIAN	35.5	MEDIAN	36.5
MEAN	64.4	MEAN	63.3	MEAN	58.6	MEAN	53.9	MEAN	53.7

* LOW ASSOCIATION RECOGNITION LISTS

LIST I-G				LIST L-J			
MULE	29	LAND	100	TANK	19	SHOW	100
FORK	31	POST	100	YARD	100	FROG	25
DEED	50	SONG	100	SOUL	100	BOOK	100
WEST	100	ACHE	28	TRAY	17	LINK	24
LORD	100	BOAT	100	SEAT	100	CODE	21
HOSE	9	CLAP	22	PILL	7	RING	100
TWIN	25	DUST	50	GATE	100	WAVE	100
SALE	50	LASS	9	WINK	20	COAT	100
KICK	47	DISH	50	SEED	50	LUCK	46
SPOT	100	MUTE	11	TOUR	20	MASK	17
	541		570		533		633
MEDIAN	48.5	MEDIAN	50	MEDIAN	35	MEDIAN	73
MEAN	54.1	MEAN	57.0	MEAN	53.3	MEAN	63.3

* Low Association Recognition Lists

The rhyme, synonym and synonym-rhyme lists are exactly the same as for the high association recognition lists (list H-G corresponding to list I-G, list K-J corresponding to list L-J).

The forty alternatives from each recognition list consisting of the responses (the second words of each of the paired associates), the rhymes, the synonyms, and the synonym-rhymes were placed in random order and can be found on the answer sheets (Appendix C).

A P P E N D I X B

PILOT STUDY RESULTS AND INSTRUCTIONS

TABLE 1. NUMBER OF ERRORS OF EACH LIST

	LOW RECALL			HIGH RECALL	
	MEAN	VARIANCE		MEAN	VARIANCE
List C-A	8.6	2.04	List B-A	1.3	1.01
List F-D	7.8	2.56	List E-D	1.0	.7

	LOW RECOGNITION			HIGH RECOGNITION	
	MEAN	VARIANCE		MEAN	VARIANCE
List L-J	5.5	3.2	List H-G	2.16	3.1
List I-G	5.2	6.5	List K-J	1.6	2.9

TABLE 2.

INSTRUCTIONS TO SS - RECALL

In this experiment you will be shown 10 pairs of words, each pair being presented for about 2-3 seconds. After presenting all 10 pairs in the list you will be shown only the first word of each pair and your task is to write down the word that went with each word. You may not be able to remember all the words. If you can't remember just put a dash alongside where you would have put the word.

INSTRUCTIONS TO Ss - RECOGNITION

In this experiment you will be shown 10 pairs of words, each pair being presented for about 2-3 seconds. After presenting all 10 pairs in the list you will be shown the first word of each of the 10 pairs. Your task is to choose the word which went with (belonged to) the first word from the list of 40 alternative words given on the answer sheet. You may not be able to remember all the words. If you can't remember please select the one you think most likely from this list of 40 words and write it down.

A P P E N D I X C

SET I AND SET II OF LISTS AS PRESENTED ON THE MEMORY DRUM

EACH WITH ITS CORRESPONDING ANSWER SHEET.

SET I

PRESENTATION LIST HIGH RECALL B-A

START	
BOOT	LACE
DIAL	TONE
JAIL	CELL
PALM	LEAF
SHOP	DOOR
GOLF	CLUB
FISH	POND
TOWN	HALL
FLEA	BITE
BASE	LINE
FINISH	

ANSWER SHEET

TOWN _____

SHOP _____

BASE _____

JAIL _____

FLEA _____

DIAL _____

FISH _____

BOOT _____

GOLF _____

PALM _____

SET I

PRESENTATION LIST	LOW RECALL F-D
START	
DECK	CHOP
COPY	PIPE
GIFT	FILE
FOOD	STAR
PACK	FREE
DESK	WIRE
SOAP	MATE
CASE	WORM
BEAN	DROP
GLUE	SITE
FINISH	

ANSWER SHEET

BEAN _____

PACK _____

SOAP _____

CASE _____

FOOD _____

DECK _____

GIFT _____

COPY _____

GLUE _____

DESK _____

SET I

PRESENTATION LIST HIGH RECOGNITION H-0

START	
MAIN	LAND
LAMP	POST
SOLO	SONG
NECK	ACHE
SAIL	BOAT
HAND	CLAP
GRAY	DUST
HEAD	LASS
SOUP	DISH
DEAF	MUTE
FINISH	

ANSWER SHEET

		ALTERNATIVES
SAIL	_____	MOON DUST SOIL MUTE LAKE BANG ROLL MAID
HAND	_____	WISH BOAT TUNE RUST BAND CHUM ACHE GANG
DEAF	_____	POLE LASS COAL SLIP SONG BAND BOIL DUMB
LAMP	_____	GAIN CLAP HOST RAID DISH SHIP GONG SAND
GRAY	_____	LAND ROOT PAIN SNAP POST MASS BOWL VOTE
NECK	_____	
HEAD	_____	
SOUP	_____	
MAIN	_____	
SOLO	_____	

SET I

PRESENTATION LIST LOW RECOGNITION L-J

START	
TANK	SHOW
YARD	FROG
SOUL	BOOK
TRAY	LINK
SEAT	CODE
PILL	RING
GATE	WAVE
WINK	COAT
SEED	LUCK
TOUR	MASK
FINISH	

ANSWER SHEET

	ALTERNATIVES
GATE _____	LOOP CAVE TASK BOOK FATE CLOG GOUT COIN
TOUR _____	FAIR CODE RING FOAM HOOD TEXT DUCK FROG
SEAT _____	SKIN PINK SNOW LOAD COOP WAVE WOOD NEXT
TRAY _____	LUCK MODE GRIN LINK PEAR RULE KING COMB
WINK _____	MASK LOOK DATE TOAD COAT JOIN SHOW COOL
SEED _____	
TANK _____	
PILL _____	
SOUL _____	
YARD _____	

SET II

PRESENTATION LIST HIGH RECALL E-D

START	
PORK	CHOP
BLOW	PIPE
NAIL	FILE
FILM	STAR
GERM	FREE
BARB	WIRE
PLAY	MATE
GLOW	WORM
TEAR	DROP
CAMP	SITE
FINISH	

ANSWER SHEET

TEAR _____

GERM _____

PLAY _____

GLOW _____

FILM _____

PORK _____

NAIL _____

BLOW _____

CAMP _____

BARB _____

SET II

PRESENTATION LIST LOW RECALL C-A

START	
FIRE	LACE
MILL	TONE
LIST	CELL
WINE	LEAF
SPUR	DOOR
MARK	CLUB
GEAR	POND
TAIL	HALL
DEBT	BITE
JOKE	LINE
FINISH	

ANSWER SHEET

TAIL _____

SPUR _____

JOKE _____

LIST _____

DEBT _____

MILL _____

GEAR _____

FIRE _____

MARK _____

WINE _____

SET II

PRESENTATION LIST HIGH RECOGNITION K-J

START	
WOOL	SHOW
LEAP	FROG
HYMN	BOOK
GOLD	LINK
ROAD	CODE
IRON	RING
SURF	WAVE
HAIR	COAT
GRIM	LUCK
NOSE	MASK
FINISH	

ANSWER SHEET

	ALTERNATIVES
SURF _____	LOOP CAVE TASK BOOK FATE CLOG GOUT COIN
NOSE _____	FAIR CODE RING FOAM HOOD TEXT DUCK FROG
ROAD _____	SKIN PINK SNOW LOAD COOP WAVE WOOD NEXT
GOLD _____	LUCK MODE GRIN LINK PEAR RULE KING COMB
HAIR _____	MASK LOOK DATE TOAD COAT JOIN SHOW COOL
LEAP _____	
GRIM _____	
WOOL _____	
IRON _____	
HYMN _____	

SET II

PRESENTATION LIST LOW RECOGNITION I-G

START	
MULE	LAND
FORK	POST
DEED	SONG
WEST	ACHE
LORD	BOAT
HOSE	CLAP
TWIN	DUST
SALE	LASS
KICK	DISH
SPOT	MUTE
FINISH	

ANSWER SHEET

	ALTERNATIVES
LORD _____	MOON DUST SOIL MUTE LAKE BANG ROLL MAID
HOSE _____	WISH BOAT TUNE RUST BAND CHUM ACHE GANG
SPOT _____	POLE LASS COAL SLIP SONG RAND BOIL DUMB
FORK _____	GAIN CLAP HOST RAID DISH SHIP GONG SAND
TWIN _____	LAND ROOT PAIN SNAP POST MASS BOWL VOTE
WEST _____	
SALE _____	
KICK _____	
MULE _____	
DEED _____	

APPENDIX D

RECALL AND RECOGNITION INSTRUCTIONS

Instructions to Ss - Recognition

In this experiment you will be shown 10 pairs of words, each pair being presented for about 1 second. After presenting all 10 pairs in the list you will be shown the first word of each of the 10 pairs. Your task is to choose the word which went with (belonged to) the first word from the list of 40 alternative words given on the answer sheet. You may not be able to remember all the words. If you can't remember please select the one you think most likely from this list of 40 words and write it down.

The words on your answer sheet will be in a different order from those on the drum.

Instructions to SS - Recall

In this experiment you will be shown 10 pairs of words, each pair being presented for about 1 second. After presenting all 10 pairs in the list you will be shown only the first word of each pair and your task is to write down the word that went with each word. You may not be able to remember all the words, if you can't remember just put a dash alongside where you would have put the word.

The words on your answer sheet will be in a different order from those on the drum.

APPENDIX E

EXPERIMENTAL QUESTIONNAIRES

QUESTIONNAIRE I

Please put a tick in the appropriate box

1) Which task did you find the easier

remembering the words ☐

OR finding the correct word from the list of alternatives ☐

Remembering the words yesterday ☐

OR remembering the words today ☐

finding the correct word from the list of alternatives yesterday ☐

OR

finding the correct word from the list of alternatives today ☐

2) When you were shown the lists do you consider that you were given

too much time ☐

OR about the right amount of time ☐

OR too little time ☐

in which to read the pairs of words.

QUESTIONNAIRE II

People remember things in a number of different ways. Some of these are listed below. As I read out each pair of words from your answer sheet I want you to tell me just how you remembered. You may have used a method not listed below or you may have used more than one method.

1) You remembered the second word in the pair because the first letter was similar to the first letter in the first word of the pair e.g. home - hill.

2) You remembered the second word in the pair because the last letter was similar to the last letter of the first word of the pair e.g. pot - hut.

3) You remembered the second word of the pair because the word or part of the word sounded like the first word of the pair e.g. cap - mat.

4) You remembered the second word of the pair because it looked like or reminded you of the first word of the pair e.g. shin - skin.

5) You remembered the second word of the pair because you formed a mental picture of it.

6) You remembered the second word of the pair because you formed a mental picture of both words in the pair as one object e.g. paper-clip.

7) You remembered the second word of the pair because you said both words in the pair to yourself as you saw them.

8) You remembered the second word of the pair because you repeated both words in the pair twice or more times to yourself.

9) You remembered the second word of the pair because both words in the pair reminded you of another word which enabled you to remember both of them e.g. car-(travel)-plane.

10) You remembered the second word of the pair by some other method. Please describe this:

APPENDIX F

TABLE 1. DIAGNOSTIC CATEGORIES OF SCHIZOPHRENICS

DIAGNOSTIC CATEGORIES	FREQUENCY in each category	
	Female	Male
Paranoid Schizophrenia	3	5
Schizophrenia (undifferentiated)	3	4
Simple Schizophrenia	1	1
Schizo-affective Schizophrenia	3	0
Schizophrenia with paranoid and affective features	1	1
Hebephrenic Schizophrenia	1	0
Catatonic Schizophrenia	0	1

TABLE 2. STATUS OF SCHIZOPHRENICS

STATUS CATEGORIES	FREQUENCY	
	Female	Male
Volumtary Inmate	5	3
Section 5	3	1
Section 8	3	8
Informal 9	1	0

TABLE 3. PERIOD OF CURRENT ADMISSIONS OF SCHIZOPHRENICS

CURRENT ADMISSION CATEGORIES	FREQUENCY	
	Female	Male
Less than 1 month	3	4
1 month	2	2
2 months	3	3
3 months	0	1
4 months	1	0
5 months	1	0
6 months	1	0
7 months	0	2
8 months	0	0
9 months	1	0

TABLE 4. ONSET OF SCHIZOPHRENIA - INDEX OF ONSET FROM DATE OF EARLIEST PRIOR HOSPITALIZATION

CATEGORIES BY EARLIEST PRIOR HOSPITALIZATION (in months)	FREQUENCY	
	Female	Male
0 - 3	7	6
4 - 6	1	0
7 - 9	2	1
10 - 12	0	1
13 - 18	0	1
19 - 24	1	1
25 - 30	0	0
31 - 36	0	0
37+	1	2

APPENDIX G

COMPARISON OF NORMAL AND SCHIZOPHRENIC SAMPLES

TABLE 1. COMPARISON OF SAMPLES BY MARRIAGE

NORMAL SAMPLE			SCHIZOPHRENIC SAMPLE		
	Male	Female		Male	Female
Married	8	8	Married	1	5
Unmarried	4	4	Unmarried	11	7

TABLE 2. COMPARISON OF SAMPLES BY AGE

	NORMAL SAMPLE		SCHIZOPHRENIC SAMPLE	
	Male	Female	Male	Female
Mean Age	27	24 yr. 8 mo.	26 yr. 10 mo.	24 yr. 10 mo.
	Both Male & Female		Both Male and Female	
Mean Age	25 yr. 10 mo.		25 yr. 10 mo.	
Age Range	18 yr 11 mo - 34 yr 11 mo.		16 yr. 1 mo - 41 yr. 11 mo.	

TABLE 3. COMPARISON OF SAMPLES BY EDUCATIONAL ATTAINMENT

	NORMALS - by frequency	SCHIZOPHRENICS - by frequency
Total number of years at secondary school	74	76
	EDUCATIONAL ATTAINMENT	EDUCATIONAL ATTAINMENT
School Certificate	9	9
University Entrance	5	4
Higher School Certificate	2	2
Commercial Qualifications	3	2

TABLE 4. COMPARISON OF SAMPLES BY OCCUPATIONAL CATEGORY

NORMALS		SCHIZOPHRENICS	
FREQUENCY	OCCUPATIONAL CATEGORIES	FREQUENCY	OCCUPATIONAL CATEGORIES
1	Training-college student	1	Graphic art student
1	Primary school teacher	1	1 yr. training college
1	M.Ag.Sci. student	1	MA student
1	Radiographer	1	Architect
1	Registered general nurse	1	Community nurse
1	University Lecturer (PhD)	1	Medical practitioner and psychiatrist
1	Homecraft teacher	1	Dancing teacher
2	Female factory workers	2	Female factory workers
6	Office/clerical females	5	Office/clerical females
1	Panelbeater	1	Schoolgirl
1	Company representative	1	Male clerk
6	Carpenters/builders	7	Male labourers
1	Fitter/joiner	1	Fisherwoman

APPENDIX H

ALLOCATION OF SUBJECTS TO EXPERIMENTAL CONDITIONS

TABLE 1. NUMBERS OF NORMAL AND SCHIZOPHRENIC SUBJECTS FALLING IN VARIOUS EDUCATIONAL CATEGORIES

	NORMALS	SCHIZOPHRENICS		χ^2
More than three years	8	11	19	
Three years	9	6	15	1.0736
Less than three years	7	7	14	(2df)
	24	24		nonsignificant

TABLE 2. NUMBERS OF NORMAL AND SCHIZOPHRENIC SUBJECTS FALLING IN THE VARIOUS MILL-HILL GRADES

GRADES	NORMALS	SCHIZOPHRENICS
B+	2	0
B	0	1
B-	0	1
C+	1	2
C	5	1
C-	3	1
D+	1	1
D	1	3
D-	2	2
E+	1	2
E	4	2
E-	4	8

Wilcoxin Rank Sum Test, (Bradley p. 105-114) using method A for tied ranks (p. 49-50) gives lower bound p = between .05 and .10, and upper bound p > .20.

TABLE 3. COMPARISON OF AGE RANGES AND MEANS OF NORMAL AND SCHIZOPHRENIC SUBJECTS ASSIGNED TO LISTS SETS I AND II

LIST I		
	MEAN	RANGE
Normal	26 yr	18 yr 11 mo - 34 yr 11 mo
Schizophrenic	23 yr 4 mo	17 yr 3 mo - 32 yr 11 mo

LIST II		
	MEAN	RANGE
Normal	25 yr 8 mo	20 yr 6 mo - 31 yr 10 mo
Schizophrenic	28 yr 3 mo	16 yr 1 mo - 41 yr 11 mo

TABLE 4. NUMBERS OF NORMAL AND SCHIZOPHRENIC SUBJECTS OF VARIOUS GRADES, ASSIGNED TO LIST SETS I AND II

	LIST I					LIST II				
GRADES	A	B	C	D	E	A	B	C	D	E
NORMALS	0	1	4	0	7	0	1	5	4	2
SCHIZOPHRENICS	0	0	1	4	7	0	2	3	2	5

TABLE 5. NUMBER OF NORMAL AND SCHIZOPHRENIC SUBJECTS OF VARIOUS YEARS OF SECONDARY EDUCATION ASSIGNED TO LIST SETS I AND II

	LIST I		
YEARS OF SECONDARY EDUCATION	Less than 3	3	More than 3
NORMAL	4	5	3
SCHIZOPHRENIC	3	2	7

	LIST II		
YEARS OF SECONDARY EDUCATION	Less than 3	3	More than 3
NORMAL	3	4	5
SCHIZOPHRENIC	4	4	4

TABLE 6. SCHIZOPHRENIC SAMPLE

Ss No.	MARITAL STATUS M/S	SEX M/F	AGE Yr/Mo.	YEARS OF SECONDARY EDUCATION	OCCUPATION	MILL-HILL Score	MILL-HILL Grade
Condition I							
List I							
25	M	F	25.0	4	Ins. Clerk	32	D
26	M	F	32.11	4	Sh/Typist	44	C+
27	M	M	23.5	2	Driver	18	E-
List II							
37	M	F	38.7	3	Dancing Teacher	39	C-
38	S	M	33.8	2	Freezing Worker	43	C+
39	S	M	35.11	4	Architect	46	B-
Condition II							
List I							
28	S	F	21.3	1	Machinist	18	E-
29	S	M	25.0	4	MA Student	27	E
30	S	M	20.2	4	Warehouseman	31	D-
List II							
40	S	F	16.1	2	Schoolgirl	22	E-
41	S	F	17.5	4	Art Student	17	E-
42	S	M	16.1	2	Maori Shearer	23	E-
Condition III							
List I							
31	S	F	19.10	4	Receptionist	28	E+
32	S	F	17.3	3	Fisherwoman	32	D
33	S	M	18.3	4	Storeman	28	E+
List II							
43	S	F	18.0	3	Packer in factory	17	E-
44	S	M	28.3	3	Labourer	30	D-
45	S	M	27.0	5	Flax Miller	24	E
Condition IV							
List I							
34	S	F	24.11	3	Community nurse	16	E-
35	S	M	28.6	4	Clerk	35	D+
36	S	M	23.11	1	Timb. Mill Wker.	11	E-
List II							
46	M	F	34.4	2	Sh/Typist	33	D
47	M	F	32.1	3	Secretary	42	C
48	S	M	41.11	5	Med. Practitioner	48	B

TABLE 7. NORMAL SAMPLE

Ss No.	MARITAL STATUS M/S	SEX M/F	AGE Yr/Mo.	YEARS OF SECONDARY EDUCATION	OCCUPATION	MILL-HILL Score	Grade
Condition I							
List I							
1	S	F	18.11	4	Training-college student	39	C-
2	M	F	22.0	4	Receptionist	15	E-
3	M	M	25.6	2	Builder/ carpenter	23	E-
List II							
13	M	F	26.0	4	Radiographer	43	C+
14	M	M	31.10	0	Maori Builder/ carpenter	35	D+
15	S	M	23.1	6	M.Ag.Sci. stu.	34	D
Condition II							
List I							
4	M	F	22.4	2	Punch-card op.	25	E
5	M	M	25.5	3	Builder	40	C
6	S	M	21.7	3	Panelbeater	25	E
List II							
16	M	F	21.7	3	Sh/Typist	30	D-
17	S	F	20.6	4	Sh/Typist	39	C-
18	M	M	27.0	3	Builder/ carpenter	31	D-
Condition III							
List I							
7	M	F	24.9	3	Typist	23	E-
8	S	F	23.4	4	Secretary	51	B+
9	M	M	24.9	3	Builder/ carpenter	28	E+
List II							
19	M	F	23.9	2	Insp. wk. in factory	13	E-
20	M	M	25.9	2	Salesman Comp. Rep.	25	E
21	S	M	23.7	4	Primary teacher	41	C
Condition IV							
List I							
10	M	F	34.11	2	Machinist	39	C-
11	M	M	34.4	3	Fitter/joiner	41	C
12	M	M	34.1	2	Carpenter	26	E
List II							
22	M	F	30.3	3	Homecr. Teacher	52	B+
23	S	F	28.0	3	General Nurse	42	C
24	S	M	27.1	5	Uni. Lecturer	42	C